Hybrid Stereo Camera

An IBR Approach for Synthesis of Very High Resolution Stereo Image Sequences

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IMAX

http://www.sarnoff.com/search/tech_papers/hybrid/index.asp

Motivation

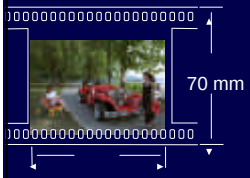
Extremely High Visual Quality

Stereo Creation & Projection
4K-8K digital resolution per eye
World's Largest Film Format

IMAX 3D Content

CG Animations
Live Action
Mixed CG & Live Action

Limitations on IMAX 3D Content Creation



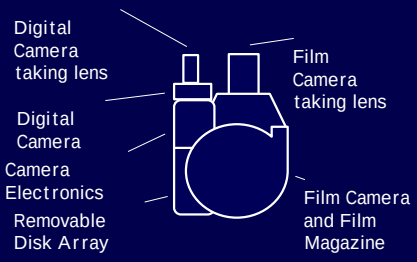
Live Action Content

- Camera is very large.
- Requires two strips of large format film.
- Size of camera and cost of film limits production.

CG Content

- 6-14 hours rendering time per frame !

Solution: Hybrid Stereo Camera



Goals

Expand the possibilities for 3D Cinematography:

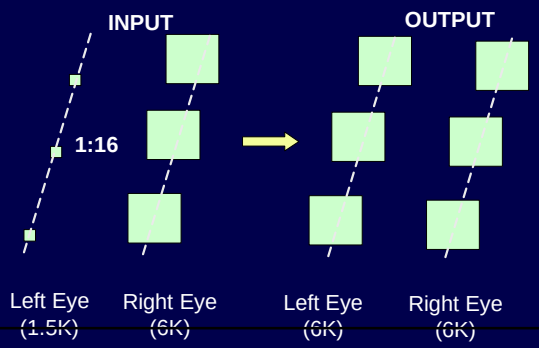
Can Computer Vision & IBR deliver High Quality ?

With reduced cost & time ?

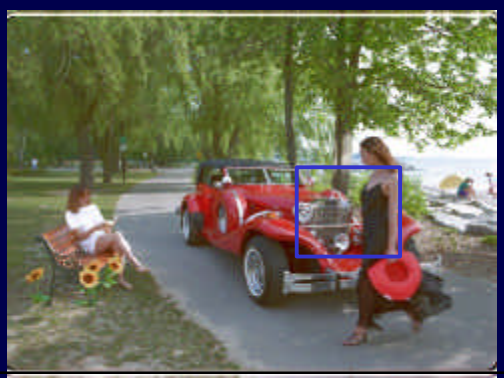
Explore an Analysis-Test-Synthesis Framework for Image-based Modeling & Rendering

Hybrid Stereo Camera

... pure upsampling is not an option ...

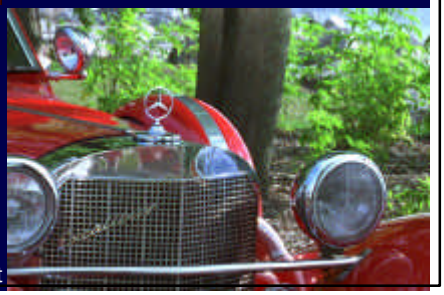


Live Action Sequence

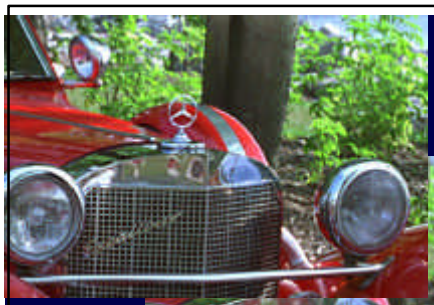


Live Action : Hybrid Input

Left



Right



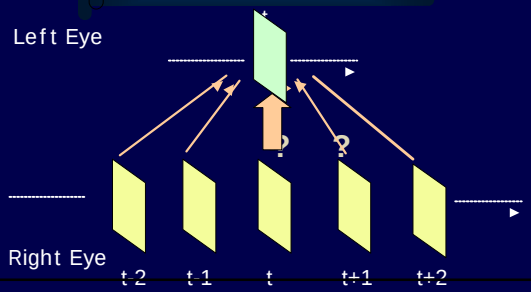
Synthesized Output

Left

Right

How can the Hybrid Camera be Realized ?

Render the High-Res content into the coordinate system of the Low-Res Frame !



Approach

Convergence of Computer Vision & IBR

- Compute stereo disparities at lo-res.
- Compute motion (Optical Flow) at lo-res.
- Compute quality map at lo-res.
- Synthesize hi-res frame.
- Fill-in and color correct mis-matched pixels.
- Temporal de-scintillation.

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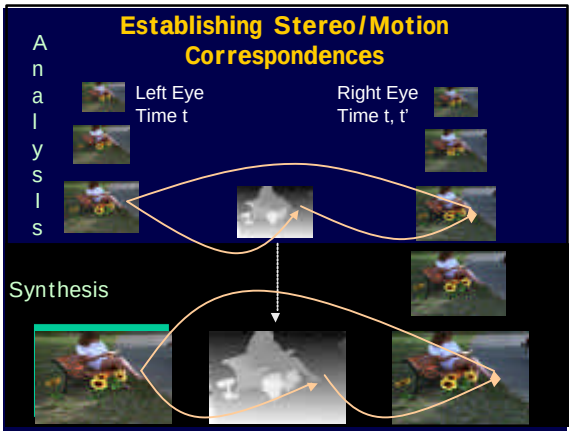
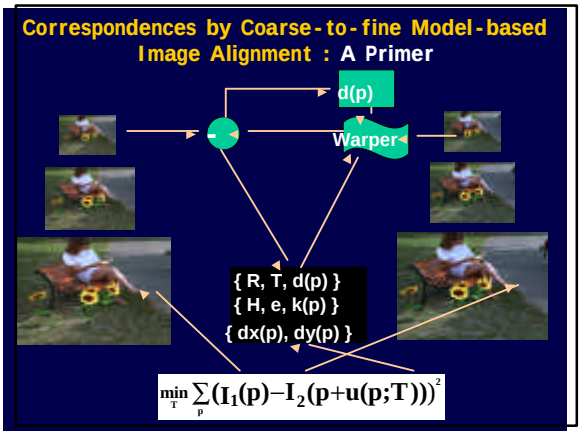
Establishing Stereo/Motion Correspondences



Correspondences by Coarse-to-fine Model-based Image Alignment : A Primer



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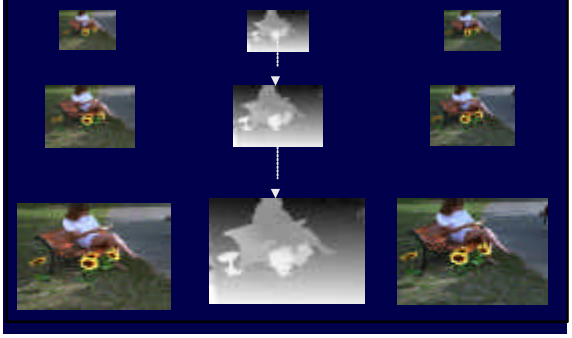
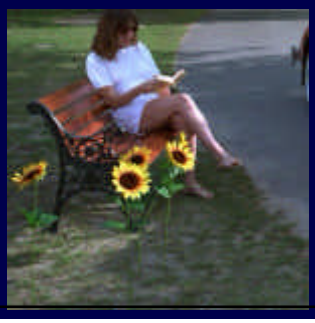


3D Stereo Correspondence

Original Left-Right Pair



3D Stereo Correspondence

Disparity/Correspondence Map

3D Stereo Correspondence

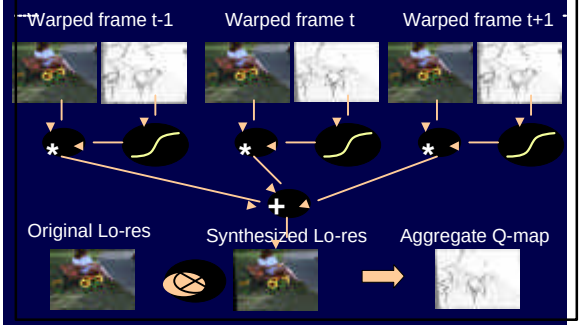
Original Left & Disparity-warped Right Frame

Quality of Alignment Map

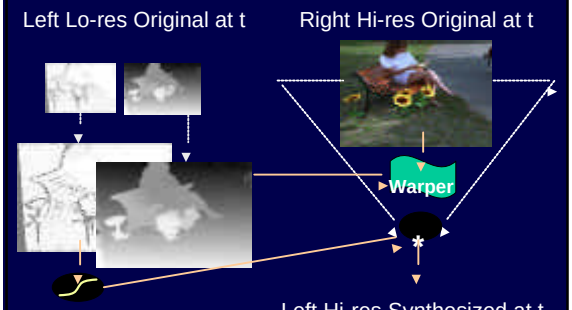
Associate a [0,1] value at each pixel

Aggregate Quality Map at Lo-Res

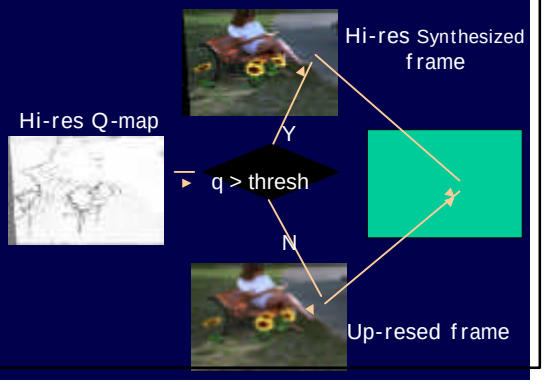
Using Stereo-Motion Synthesis



Synthesis at the High-Resolution



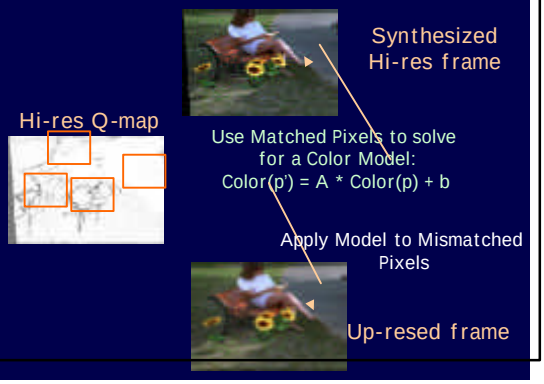
Filling-in Mismatched Pixels at Hi-res



Filling-in Mismatched Pixels at Hi-Res

Sample Result

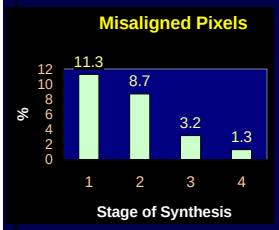
Color Correction

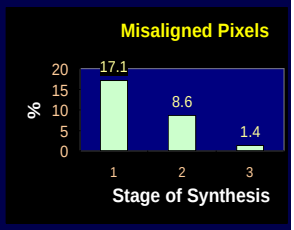


Color Correction

Sample Result

Quantitative Validation





Live Action

CG Animation

Synthesis vs. Up-resing : Live Action

Synthesis vs. Up-resing : CG Animation

Computational Time

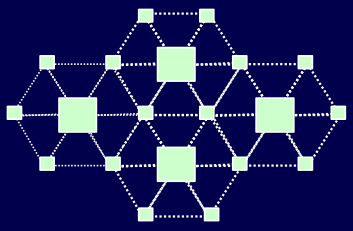
- Research Code : Currently about 45 mins. per 4K frame on an SGI 350 Mhz Octane.
- Optimizations can easily reduce the time to about 4-5 mins.

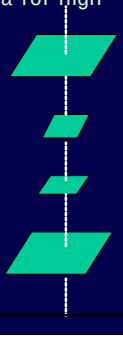
Potential cost/time reduction for a 45 min. feature

180 CPUs / 6 months ➡ 30 CPUS / 2.5 months

Generalizations

Key Idea : IBMR can exploit the availability of lower resolution or other similar data for high quality rendering.





Summary

- Applied an Analysis-Test-Synthesis Framework to high quality stereo synthesis.
- Initial validation of quality of synthesis is very encouraging.
- Potential for new research and applications based on generalizations of the framework.

Acknowledgements

- Ed Lepieszo & Carol Harrison, IMAX
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